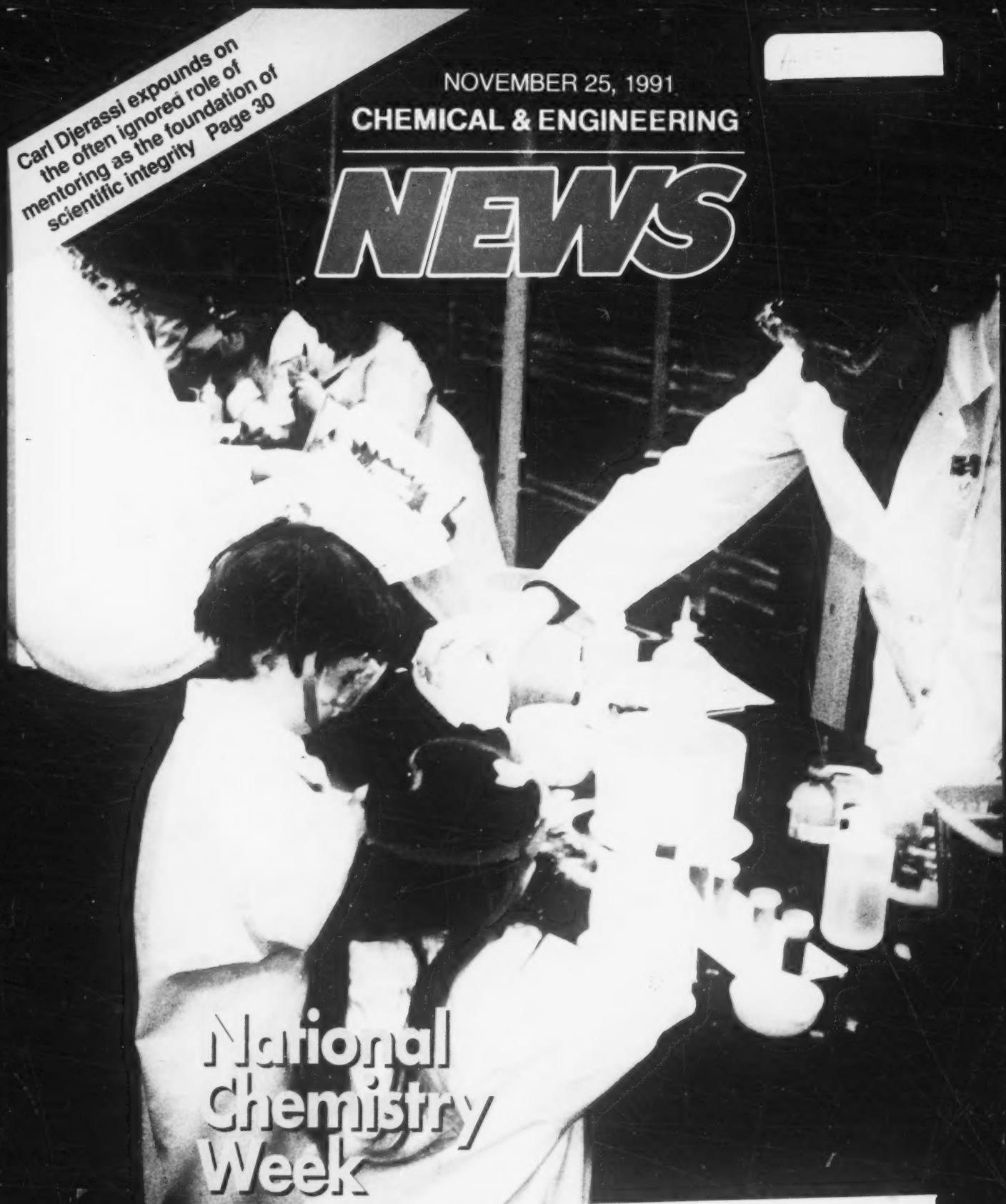
NOVEMBER 25, 1991
CHEMICAL & ENGINEERING
NEWS

Carl Djerassi expounds on the often ignored role of mentoring as the foundation of scientific integrity Page 30



National Chemistry Week

ACS local sections outd[illegible] themselves in presenting [illegible]emistry to the public

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CHEMICAL & ENGINEERING
NEWS
Volume 69, Number 47
CENEAR 69 (47) 1–56
ISSN 0009-2347
NOVEMBER 25, 1991

News of the Week

■ **FDA revamps drug approval program to speed up clearance, but critics fear public protection from unsafe and ineffective drugs may suffer.** Page 4

■ **Former ACS Board member Helen M. Free, of Miles Inc.'s Diagnostics Division, wins ACS election for 1992 president-elect.** Page 5

■ **Dow Chemical European subsidiary will pay $100 million over three years to purchase 90% of Czech acrylics firm, giving Dow a springboard into Eastern Europe.** Page 6

■ **Injecting tons of ethane or propane into stratosphere over Antarctica could stop ozone hole formation by scavenging the chlorine atoms that cause it, suggest three California scientists.** Page 6

Cover: Columbus Section's Family Chemistry Day at Center of Science & Industry. Photo by Robert Schwerzel

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Business

Rohm & Haas' growth plans will continue to include research and development as an essential component. **Page 10**

Government

Legislation to step up research on indoor air pollution is approved by Senate, despite Administration opposition to the bill. **Page 15**

Fiscal 1992 funding for NIH is up 9%, but some spending is deferred until final day of that fiscal year. **Page 16**

Science/Technology

Traditional boundaries of chemistry are broadening in response to changing landscape of science. **Page 18**

First radar images ever made of Mercury indicate possible ice deposits at planet's north pole. **Page 22**

Soil remediation efforts gain momentum with opening of Netherlands plant that washes soil free of contaminents. **Page 24**

Viewpoint

Scientists must give more attention to the mentoring process in effort to prevent science bashing, in the view of Stanford University's Carl Djerassi. **Page 30**

ACS News

This year's National Chemistry Week, the third nationwide public relations extravaganza sponsored by ACS, was a huge success, with an unprecedented variety of activities by the society's local sections. **Page 34**

Chemical & Engineering News
1155—16th St., N.W., Washington, D.C. 20036
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Published by
AMERICAN CHEMICAL SOCIETY
(202) 872-4600; TDD (202) 872-4432
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Subscription Rates 1991: Printed editions: nonmembers U.S. 1 yr. $95, 2 yr. $171; outside U.S. 1 yr. $131, 2 yr. $243. Air freight rates available on request. Rates above do not apply to nonmember subscribers in Japan, who must enter subscription orders with Maruzen Co. Ltd., 3-10 Nihonbashi 2-chome, Chuo-ku, Tokyo 103, Japan. Tel: (03) 272-7211. Single copies: Current $12. Rates for back issues and volumes are available from Microforms & Back Issues Office, ACS, 1155—16th St., N.W., Washington, D.C. 20036. Back and current issues available on microfilm and microfiche. Rates on request from Microform Program, ACS.

Chemical & Engineering News (ISSN 0009-2347) is published weekly except for the last week in December by the American Chemical Society at 1155—16th St., N.W., Washington, D.C. 20036. Second-class postage paid at Washington, D.C., and additional mailing offices. POSTMASTER: Send address changes to Chemical & Engineering News, Membership & Subscription Services, P.O. Box 3337, Columbus, Ohio 43210. ACS assumes no responsibility for the statements and opinions advanced by the contributors to its publications.

Advertising Management: CENTCOM LTD.
(For list of offices see page 55)
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LETTERS

Affectionate respect

Einstein was once overheard to say, I expect inadvertently, "Chemistry is that subject which is too difficult for chemists"—and he didn't even know about low-temperature fusion! What might he have thought about anguish over the popular pronunciation of chemotherapy?

One could, of course, have snapped back at him that theorizing is too difficult for theorists; but let's hear it instead for an affectionate respect of each other in striving for excellence in work and words.

John W. Gibson
Oakland, Calif.

Paint's economic outlook

I have some comments regarding your cover story on the paint and coatings industry (C&EN, Oct. 14, page 29).

Government statistics employ the unit "gallon" to track paint makers' economic performance. In his article, Marc S. Reisch used these statistics to show that although "shipments declined more than 6% for the second year in a row ... paint makers received a record value for their shipments."

This does not necessarily mean that customers are paying more to paint their wagons. Environmentally responsible paint companies are reducing emissions of volatile organic compounds (VOCs) by manufacturing more concentrated paints. For example, a car that 30 years ago was painted with 1 gal of high-gloss lacquer, today requires only 2 qt of low-VOC polyurethane to cover the same area. Price per gallon, therefore, does not paint an accurate picture.

There is another problem in using gallons to track the paint industry's economic outlook. For most industries, decreased volume sustained over a long period of time signals hard times ahead. This is not necessarily true for the paint industry, which will continue to record declines in total gallons of shipments as paint becomes more concentrated. Similarly, what forecast would be given if there were a sudden surge in gallon caused by (perhaps) introduction to the marketplace of a dilute water-based paint with the durability of an enamel or the weatherability of a urethane?

Not all chemical industries track economic trends through volumes produced. The pharmaceutical industry tracks doses, not grams. The paper industry tracks pages, not weight. Greater insight into the paint industry's economic health could be gained by tracking the amount of solid (or film-forming) material dissolved or suspended in each gallon of paint. These figures are generally available.

Richard S. Valpey III
Low-VOC Project Leader
Sherwin-Williams, Chicago

Chemistry/biology interface

I would like to offer some further insight into the ACS presidential conference on "Expanding the Chemistry/Biology Interface: the Education of Future Scientists," which I organized, as a member of the ACS Committee on Science with other members Harry Gray and Peter Beak, and chaired at Carnegie Institution of Washington on Oct. 16 (C&EN, Oct. 28, page 23). Enthusiastic staff support was provided by Kathi Ream and John Malin. Maxine Singer, president of Carnegie Institution, graciously lent her presence to the conference and gave us the benefit of her experiences, particularly in small colleges, which educate such a disproportionately large number of graduate students in chemistry and biology.

The problem of educating students more effectively at the chemistry/biology interface has effects on the biotechnology industry and our competitive effectiveness worldwide in industries that depend on biotechnology. The discussion at the conference led to the recommendation of a four-point program to provide better opportunities for students to understand both chemistry and biolo-

Notice to members wishing to resign

ACS members who wish to resign their membership at the end of 1991 should do so now by letter to the ACS executive director. Bylaws specify that anyone who fails to resign by Dec. 31 will be carried on the rolls in 1992 as a member and will be responsible for dues. Failure to pay dues does not constitute a resignation.

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DRUG APPROVAL PROCESS: Mixed reviews for FDA reform plans

Mixed reviews are greeting a new 11-point program to reform the Food & Drug Administration's drug approval process.

The Pharmaceutical Manufacturers Association paints the program as "one of the most important developments in many years in addressing the inefficiencies of the U.S. drug approval process." But some consumer advocate groups and lawmakers view it as a "thinly veiled" effort to weaken FDA and deter it from its prime purpose: protecting the public from unsafe and ineffective drugs.

FDA has the authority to implement the program immediately, says an agency spokesman. However, several key lawmakers are asking FDA not to carry out the reforms until their committees have an opportunity to thoroughly review and evaluate them.

Reforms would lop 44% off approval time for drugs to treat lethal illnesses

Step	Average review time, months: Current	Average review time, months: After reform	Time saved, months
Preclinical testing	18	15	3
IND[a] approval	1	1	0
IND phase I (Healthy volunteers)	6	6	0
IND phase II (Hundreds of patient volunteers)	18	34	20
IND phase III (Thousands of patient volunteers)	36		
NDA[b] preparation time	8	4	4
FDA approval Process	30	6	24
TOTAL TIME	117 (9.75 years)	66 (5.5 years)	51 (4.25 years)

a Investigational New Drug. b New Drug Application.

Developed by the White House Council on Competitiveness, the program is expected to cut up to four years from the nearly 10 years it now takes to bring to market drugs for treating serious or life-threatening illnesses, and maladies for which there are no current treatments. The program will do this by putting these drugs into a fast-track approval process that uses "surrogate endpoints" or other evidence to indicate a drug's effectiveness. For cancer a surrogate endpoint might be tumor shrinkage; for AIDS it might be an increase in a particular white blood cell moiety.

Another means of getting such drugs to market sooner is to standardize FDA's drug approval process with those of other industrialized nations. Such harmonization, the council believes, would move industrialized countries toward common testing procedures that would eliminate duplicative effort.

"Patients with serious and life-threatening diseases will benefit from earlier access to important new drugs, unnecessary regulatory burdens will be eased, and U.S. competitiveness will be strengthened," notes Vice President Dan Quayle. Quayle chairs the council, whose members also include the secretaries of the Commerce and Treasury departments.

The council touts another reform—use of nongovernment scientific experts to perform reviews under contract to FDA—as a way to shrink the backlog of drug applications. This external review process will be used only for those drug applications not likely to offer difficult scientific questions. "We need to supplement our existing talent with some of the strong talent on the outside," says FDA Commissioner David A. Kessler.

Drugs to treat allergies, pain, inflammation, and infections are likely candidates for external review. The council expects such review and other management improvements to cut approval time to seven years from almost 10 now.

However, such external review raises the specter of conflict of interest and delay, charges health affairs activist Sidney M. Wolfe, director of Public Citizen's Health Research Group. "Many [external reviewers] will have financial and other links to the drug industry, which could endanger the objectivity of the review. ... Reviewers without drug industry connections, who may tend to lack experience in the drug approval process ... could actually delay approval."

Former FDA chief counsel Peter B. Hutt, who "enthusiastically supports" the reforms, disagrees. "There is a substantial body of members emeritus of FDA advisory committees who have been exposed to the agency and its processes." Many have no links to industry, he notes.

Wolfe also finds the international harmonization reform particularly troublesome, even dangerous. U.S. acceptance of foreign drug testing data "could mean a lowering of our standards," he points out. But Hutt says such standardization "may make our [process] more efficient, not lower it." He doesn't expect harmonization to lead to another thalidomide—a drug approved in Europe but not in the U.S. and which caused severe birth deformities.

Three members of Congress who play a key role in health affairs share Wolfe's discontent. Sen. Edward M.

Kennedy (D.-Mass.), Rep. John D. Dingell (D.-Mich.), and Rep. Henry A. Waxman (D.-Calif.) say, "We are concerned, at a minimum, that the proposals will lead to inconsistent and uncertain standards for review, and could permit commercial interests to override the objectivity that is essential in evaluating drugs."

Moreover, Public Citizen's Congress Watch is concerned about the role and workings of the Council on Competitiveness. "Consumer groups and the public had absolutely no input into these recommendations," says Congress Watch spokesman Nancy Watzman. "But, we suspect, the pharmaceutical industry was intimately involved in their development." The council's activities are closely guarded, with little public accountability, and are not subject to the Freedom of Information Act.

Lois Ember

Helen Free wins ACS presidential election

Helen M. Free has convincingly won the American Chemical Society's election for 1992 president-elect. A professional relations consultant for Miles Inc.'s Diagnostics Division in Elkhart, Ind., and an employee of Miles for the past 47 years, Free also will serve as ACS president in 1993 and as a member of the ACS Board of Directors from 1992 to 1994.

Free has been active in ACS governance for many years, including two recent terms on the ACS Board—as director-at-large in 1988–90 and as Region V director in 1983–85.

According to mail ballots counted last week at ACS headquarters, Free received 18,071 votes, almost 61% of the total. Her opponent, Henry F. Whalen Jr., corporate vice president and director of corporate development at PQ Corp. in Valley Forge, Pa., received 11,723 votes.

Four other directors also were elected to serve three-year terms on the ACS Board—two directors-at-large and two regional directors.

Four candidates vied to become directors-at-large, who are elected by voting members of the ACS Council. The winners were incumbent C. Marvin Lang with 208 votes, and former ACS president Gordon L. Nelson with 189 votes. It will be the second consecutive three-year term on the board for Lang, who is professor of chemistry at the University of Wisconsin, Stevens Point. Nelson returns to the board after a two-year absence, having served a three-year presidential succession in 1987–89 and as Region I director in 1977–85. Nelson is dean of Florida Institute of Technology's College of Science & Liberal Arts, Melbourne, Fla.

The two unsuccessful candidates were Larry F. Thompson and Peter E. Yankwich, with 158 and 144 votes, respectively. Thompson heads the organic materials and chemical engineering departments at AT&T Bell Laboratories in Murray Hill, N.J., and chairs the Society Committee on Chemical Abstracts Service. Incumbent Yankwich, who was running for his third consecutive term, is executive officer of the National Science Foundation's Directorate for Education & Human Resources in Washington, D.C.

In both regional director races, lack of a simple majority among three candidates for each post required adding to the totals of the first- and second-place candidates the second-choice votes on the ballots of the third-place candidates. By this procedure, James G. Bennett Jr. received 1990 votes to win election as director from Region I, consisting of most of New York, New England, Puerto Rico, and eastern Canada. He is principal scientist at General Electric Co. in Selkirk, N.Y. Incumbent Joan E. Shields, professor of chemistry at Long Island University in Brookville, N.Y., received 1884 votes; and William E. McEwen, Commonwealth Professor at the University of Massachusetts, Amherst, got 1014 votes.

John G. Verkade, professor of chemistry at Iowa State University, Ames, received 2262 votes to win reelection as director from Region V, which encompasses much of the Midwest, Texas, and parts of mid-Canada. This will be his second full term (counting a previous partial term, he has served since 1987). E. Ann Nalley received 1557 votes and Clara D. Craver 1084 votes. Nalley, who was nominated by petition, is professor of chemistry at Cameron University, Lawton, Okla. Craver is president of consulting firm Craver & Craver Inc., in Glendale, Mo.

Members also overwhelmingly ratified two amendments to the society's constitution. They remove gender-specific pronouns from the constitution, and create a mechanism to establish ACS international chemical sciences chapters.

Ernest Carpenter

C&EN staff photo

Helen M. Free

ACS voting breakdown

	Votes
PRESIDENT-ELECT	
Helen M. Free	18,071
Henry F. Whalen Jr.	11,723
DIRECTORS-AT-LARGE[a]	
C. Marvin Lang	208
Gordon L. Nelson	189
Larry F. Thompson	158
Peter E. Yankwich	144
REGIONAL DIRECTORS	
Region I	
James G. Bennett Jr.	1990
Joan E. Shields	1884
William E. McEwen	1014
Region V	
John G. Verkade	2262
E. Ann Nalley	1557
Clara D. Craver	1084

Note: In a three-way vote, when no candidate receives a majority, second-choice votes of the candidate receiving the lowest number of first-choice votes are added to the first-choice votes of the other two. Thus, in Region I, Bennett received 1535 first-choice and 455 second-choice votes, and Shields received 1335 first-choice and 549 second-choice votes. In Region V, Verkade received 1873 first-choice and 389 second-choice votes, and Nalley received 1286 first-choice and 271 second-choice votes. a Elected by vote of councilors.

the bill to the floor. Lautenberg is one of the bill's original cosponsors. In terms of public health, Lautenberg expects that "this bill will provide us a much needed ounce of prevention and help us to avoid the costly pound of cure."

The bill calls on EPA to report to Congress on the subject of chemical sensitivity disorders, including multiple chemical sensitivities. The report is to address the underlying causes of these disorders, identify their prevalence, and make recommendations for actions to prevent and respond to such illnesses. EPA is also to analyze the adequacy of existing ventilation standards and guidelines to protect public health, and the National Institute of Occupational Safety & Health is to carry out a program to demonstrate methods of assessing and mitigating indoor air contamination in "sick buildings."

In addition, the bill directs EPA to develop a national response plan identifying actions to be taken to reduce indoor air contamination; establishes an office of indoor air quality within EPA; sets up an interagency council on indoor air quality to oversee the indoor air activities of various federal agencies; and provides incentives, in the form of grants, for states to develop their own air quality management and assessment strategies.

To carry out all these programs the bill authorizes total funding of $48.5 million per year for each fiscal year from 1992 to 1996. That yearly figure breaks down into $20 million for research and health advisories; $12 million for state management and response grants; $10 million for EPA operations; $5 million for the building assessment program; and $1.5 million for the interagency council.

Janice Long

NIH budget up 9% but some spending "on ice"

Fiscal 1992 funding for the National Institutes of Health is up 9% to just over $9 billion in the budget given final approval by Congress earlier this month. On a percentage basis NIH didn't do as well as the National Science Foundation or the Department of Energy in the 1992 budget battle, but it is still the largest supporter, by far, of nondefense R&D. Its nearest competitor, the National Aeronautics & Space Administration, has a fiscal 1992 R&D budget of $6.4 billion (C&EN, Nov. 4, page 26).

However, Congress put a special twist on NIH's budget this year. It told the agency that it cannot spend $563 million, or 6%, of its current budget until the final day of the fiscal year—Sept. 30, 1992. The institutes with the highest percentage increases also have the largest percentage deferrals. For example, the National Cancer Institute, whose funding is up 16% to just under $2 billion, cannot spend 11% of that until Sept. 30. For most of the institutes the deferred spending ranges between 4 and 6% of their total budget.

This sleight of hand, which pushes the actual expenditure of funds into the next fiscal year, was necessary to keep overall expenditures for the departments of Health & Human Services, Education, and Labor within their fiscal 1992 budget allocation. Deferred funding for all of them totals $3.1 billion. "Without these delays," Sen. Tom Harkin (D.-Iowa), chairman of the appropriations subcommittee that deals with the three departments, told his fellow Senators, "The bill would be cut to the bone and held to levels below last year."

However, this sleight of hand wasn't to everyone's liking. Sen. Pete Domenici (R.-N.M.), ranking minority member of the Senate Budget Committee, voted against the conference report on the Labor-HHS appropriations bill because of the budget gimmicks it contained. Domenici had another problem with the bill. "Even for the federal government," he said, "it's difficult to spend that much money in one day."

Janice Long

Congress gives NIH more funds than Administration sought

$ Millions	1992 Congressional appropriation	1992 Administration request	1991	% difference appropriation-request	% change 1991-92
National Institutes	$8177.2	$7982.0	$7439.1	2%	10%
Cancer	1989.3	1810.2	1713.8	10	16
Heart, Lung & Blood	1199.4	1209.9	1126.9	−1	6
Allergy & Infectious Diseases	971.1	976.7	907.3	−1	7
General Medical Sciences	818.9	833.2	760.2	−2	8
Diabetes, Digestive & Kidney Diseases	664.1	658.6	615.3	1	8
Neurological Disorders & Stroke	583.4	583.4	541.7	0	8
Child Health & Human Development	524.4	520.6	479.0	1	9
Aging	387.0	348.6	323.7	11	19
Eye	271.0	272.3	253.2	−1	7
Environmental Health Sciences	253.9	254.5	241.0	0	5
Arthritis & Musculoskeletal & Skin Diseases	204.5	204.8	193.2	0	6
Dental Research	160.4	160.9	148.9	0	8
Deafness & Other Communication Disorders	149.8	148.3	134.9	1	11
National Center for Research Resources	315.2	321.0	335.3	−2	−6
National Center for Human Genome Research	105.3	110.5	87.4	−5	20
Other	412.7	361.4	415.1	14	−1
TOTAL	$9010.4	$8774.9	$8276.9	3%	9%

Note: Fiscal years. Source: H. Rept. 102-282

NOTE

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Cov. 1, Pgs: 3, 4, 13, 14,

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CHEMICAL & ENGINEERING

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CHEMICAL & ENGINEERING
NEWS
DECEMBER 2, 1991

Volume 69, Number 48
CENEAR 69 (48) 1–76
ISSN 0009-2347

News of the Week

■ **Stanford University chemists have developed a method to selectively break specific bonds in a triatomic molecule using a tunable infrared laser.** **Page 6**

■ **White House Council on Competitiveness, charged with ensuring federal regulations don't overly burden industry, draws fire from Congressional Democrats for actions they call too secretive and possibly illegal.** **Page 7**

■ **Recent changes in structure and management at NSF have hurt morale, triggered complaints about director Walter Massey.** **Page 8**

■ **U.S. plastics producers have formed an industry group involving top executives in coordinating and improving plastics recycling, conservation, and resource recovery programs, and in dealing with public concern about plastics and the environment.** **Page 8**

Cover: Illustration by Deborah Bix

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Business

Increasing demand for oxygen and nitrogen bolsters profits for industrial gases, spurs producers to add capacity. **Page 13**

Government

Cryofracture's long development and testing time may rule out its use as an alternative chemical arms disposal method. **Page 19**

Congress increases Department of Defense's 1992 R&D funding 10% to $39.3 billion, 2% less than the Administration requested. **Page 21**

Science/Technology

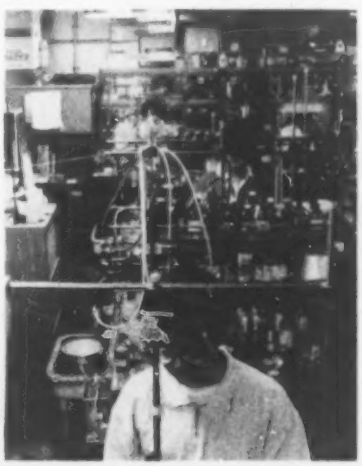
Separations technology field growing, fueled by drive for increased yields, despite long neglect by industry and education groups. **Page 27**

Books

"Science Matters: Achieving Scientific Literacy" by Robert Hazen and James Trefil stresses goal of science education for the nonspecialist as using science, not doing it. **Page 47**

Meetings

1992 Pittsburgh Conference (officially PITTCON '92) miniprogram includes listing of technical program together with registration and other information. **Page 56**



Special Report

Japan is slowly changing its infrastructure for academic science and education as economic success transforms the country, fueling its efforts to catch up scientifically with the U.S. and European countries. **Page 30**

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Chemical & Engineering News (ISSN 0009-2347) is published weekly except for the last week in December by the American Chemical Society at 1155—16th St., N.W., Washington, D.C. 20036. Second-class postage paid at Washington, D.C., and additional mailing offices. POSTMASTER: Send address changes to Chemical & Engineering News, Membership & Subscription Services, P.O. Box 3337, Columbus, Ohio 43210. ACS assumes no responsibility for the statements and opinions advanced by the contributors to its publications.

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LETTERS

Alternatives for diabetes

The article by Stephen Stinson, "New Drugs Under Development for Diabetes" (C&EN, Sept. 30, page 33), did not contain any discussion of the potential role of micronutrients in the prevention or mitigation of diabetic complications. There is ongoing research into the effects of vitamins C and E, chromium, and omega-3 fatty acids in reducing sorbitol levels, stabilizing cell membranes, reducing platelet aggregation, improving blood sugar control, and correcting blood lipid patterns.

Many laboratories are studying these nutrients in relation to diabetes and have published encouraging reports. If the beneficial effects are confirmed, these agents offer safe and relatively inexpensive alternatives or adjuvants to the drugs that are under development.

Burton Kallman
Director, Science and Technology
National Nutritional Foods Association
Costa Mesa, Calif.

Chemistry-biology interface

I was delighted to read about the ACS meeting of educators aimed at improving relations between the chemical and biological sciences (C&EN, Oct. 28, page 23). Lest we be too parochial, the same problems exist with other disciplines. Actually, chemistry can be a unifier because chemistry is what chemists do. We are in space research, biotechnology, biomedicine, electronics, telecommunications, and so forth. We are involved in basic and applied research, engineering, technology, marketing, sales, information services, law—you name it.

How do we get this across to the high school student, the college student, faculty members, and ACS members? Yes, we should have more conferences at the interface disciplines. But at some point, let's put all of this together. I personally have never been more excited by the opportunities afforded to chemists at this time. How do we get this across to others? I think we must lead in an education reform that addresses not only the national education problems and the attractiveness of chemistry as a profession for the young, but also the real problems of many of the chemists who are already practicing.

I don't believe our own membership fully appreciates the opportunities, directions, and options that are available to them at the discipline interfaces and also throughout the work force. ACS must have this as a thrust area in order to continue not only as a science society, but as a professional society concerned with its members and their opportunities, as well as with the relationship of those in the profession to the world around them. The time is also ripe for ACS to lead in developing multisociety alliances as well as in finding more economical routes for multisociety memberships as part of these directions.

Eli M. Pearce
University Professor
Director, Polymer Research Institute
Brooklyn, N.Y.

Rarely have I read more high-minded balderdash than in the article "Chemists, Biologists Seek Better Relations." Indeed, the statement that "the first semester of freshman biochemistry should be a slow introduction to the topic, largely inorganic in subject matter, and designed not to discourage students" borders on the surrealistic. How do you teach molecular biology when they can't tell a mole from a molecule?

There are indeed many problems with undergraduate chemistry education—in particular, the undervaluation of biochemistry—but the cause of change is not advanced by the self-serving and specious comments of the distinguished speakers. Would it not have been possible to invite someone who teaches ordinary undergraduates?

Does Bruce Alberts really believe that "the chemistry taught to such students hasn't changed in decades"? Has he compared Fieser and Fieser with John McMurry, or examined the successive editions of Morrison and Boyd? Is he so young that he does not remember that the sophomore year used to be devoted to qualitative inorganic analysis and quantitative analytical chemistry and that the scourge of a gently mathematical physical chemistry was reserved for seniors?

As a former member of the Committee on Professional Training, Harry Gray should be ashamed to claim that "the four-year undergraduate program has not changed in 50 years with general chemistry in the first year, organic chemistry 'dug in' and dominant in the

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Rising Demand for Industrial Gases Paves Way for Price Increases

Improving prospects for oxygen and nitrogen brighten earnings outlook for producers and spark small round of capacity expansions

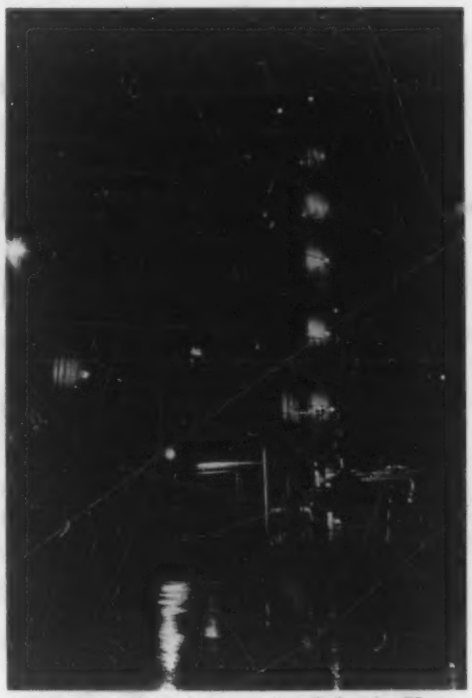
Bruce F. Greek, C&EN Houston

Despite the recession, in several parts of the country demand is increasing for the two major industrial gases—oxygen and nitrogen. Thus, producers have been able to push through a recent round of price increases. And with improved prospects for earnings, producers once again have begun increasing capacity, although total additions are small when compared with the large capacity expansions of 10 to 15 years ago.

With the current strengthening of demand for industrial gases (including argon, which is largely coproduced with oxygen), output of oxygen in 1991 is expected to be about 465 billion cu ft, up slightly from 462 billion cu ft last year. Output declined during the first half of the year, but it currently is rising. Nitrogen output this year is forecast to be up more than oxygen, about 2.5%, to 770 billion cu ft. Production of argon this year likely will be up only slightly from last year's output of 12.9 billion cu ft.

The difference between these growth rates is a result of the varying activity in the major markets of each gas. Organic chemical production, which requires the largest amount of nitrogen for blanketing and inerting, has continually operated at record volume levels this year. Steel making, the largest use of oxygen, however, has been weak because of declines in construction and automobile production. In most instances, other markets for these industrial gases are showing small increases.

Output of these industrial gases is expected to reach record levels. For example, demand for oxygen is likely to improve because of its increased use in the steel industry as well as in chemicals and other small uses, says William J. Koeppline, vice president for on-site gases at Union Carbide Industrial Gases' Linde Division. Nitrogen demand could grow faster than oxygen, mainly because of higher growth in its traditional uses such as electronics manufacturing; chemicals; food freezing; and fabrication of metals, plastics, and rubber. Argon also is expected to tack on a small increase in demand.



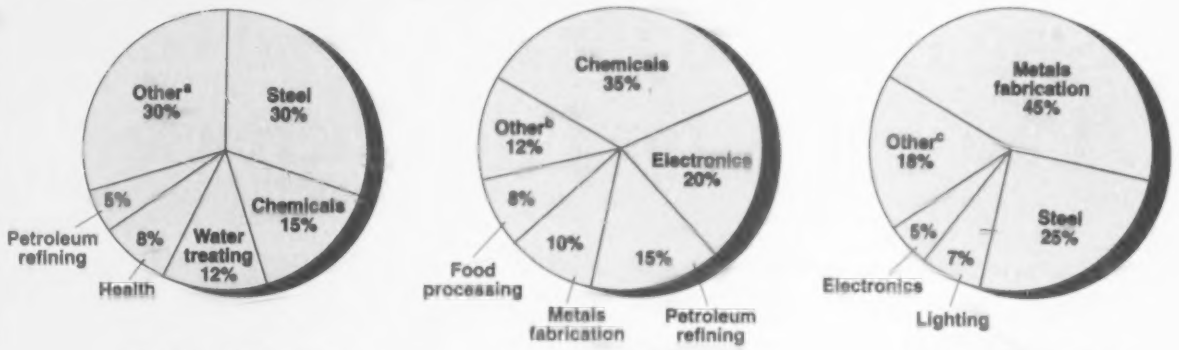
Air Products' 400 ton-per-day Orlando, Fla., plant produces nitrogen, oxygen, and argon

Longer term, growth for oxygen and nitrogen is forecast to average 3 to 5% annually. Both new uses and greater recognition of the value added by increased use of these gases will drive the growth, says Thomas H. Tough, general manager of marketing at Air Products & Chemicals. Better service by suppliers of gases also will spur growth, he adds.

Production of industrial gases by noncryogenic methods likely will grow much faster than production by the conventional method—air separation at cryogenic temperatures. Pressure swing adsorption (using molecular sieves) and membrane permeation (hollow fibers often made of organic polymers) processes to separate oxygen and nitrogen are continually being improved to give higher volumes and purities at lower costs. For example, earlier this fall, Air Products began to offer commercially a system to supply noncryogenic nitrogen in relatively small volumes at low cost to metal heat-treating companies. The system will allow control of the oxygen concentration within the nitrogen of up to 10,000 ppm and to within 5 ppm tolerance.

Some new technologies are on the horizon that would require significant increases in the use of oxygen, says Bryan P. Haley, vice president of marketing and commercial development at Airco Industrial Gases. If direct injection of coal instead of coke in the steel-making process gains wide use, oxygen demand for steel could jump. As it is, oxygen use per ton of steel slowly increases annually on average, he says. Signifi-

Use of oxygen, nitrogen, and argon breaks down this way



a Metals fabrication (cutting and welding), ceramics, pulp and paper, electronics, distributors, and National Aeronautics & Space Administration and other agencies. b Oil and gas production, rubber and plastics fabrication, float glass, miscellaneous blanketing and inerting uses, distributors, and NASA and other agencies. c Primarily distributors to small-volume users. **Source:** C&EN estimates

cant increases in oxygen demand are coming in pulp and paper manufacturing as the use of chlorine is replaced, in aluminum smelting as recycling grows, and in wastewater treatment as more oxygen is needed to make ozone.

The growth in these and other technologies using oxygen is beginning to put pressure on the available capacity in certain parts of the U.S. For example, because liquid forms of industrial gases cannot be shipped very far economically, the supply of oxygen has become tight in the Southeast, yet is plentiful in the Midwest.

Across the country, however, capacity use is increasing. The operating rate of air separation plants in 1992 will top 80% of nominal capacity, up from about 72% in 1987, Haley says. He suggests that the practical limit to operating rates on average is about 85% of capacity, to allow for maintenance and other outages.

Capacity expansions under way are either completely new plants or process improvements of varying size at existing plants. New air separation units continue to have economic advantages over older units, largely because of lower energy requirements. The investment cost of adding process improvements may be balanced by energy savings and may affect whether an older plant is kept operating.

Profits from the price increases, ranging from 5 to 10% earlier this year, spurred producers' decisions to expand capacity. But much of the price rise has gone to cover higher energy costs and only partly to offset declines in prices that occurred during the 1980s. Supplies of industrial gases probably will have to grow tighter and prices increase more before other large capacity expansions are announced.

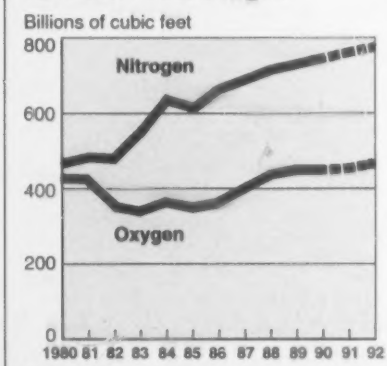
Industrial gases frequently are sold under long-term contracts containing at least three clauses relating to costs of energy, productivity, and labor that can adjust price, points out John F. Walden, vice president of Big Three Industries of Houston, a subsidiary of France's Air Liquide. Big Three Industries sells a very large portion of its industrial gases through a pipeline system along the Gulf Coast, primarily to chemical makers and petroleum refiners. Strength in these markets has led the company to begin a program that will add more than 30% to capacity by 1994.

No fixed list prices exist for the major industrial gases. Volume, equipment, purity, and service enter into pricing formulas. On a unit basis, gases delivered in cylinders cost many times more than those delivered by pipeline, with the cost of gases delivered as liquids and put through a supplier's regasifier falling in between. In volumes of several million cu ft per year, high-purity oxygen and nitrogen cost about 35 cents per 100 cu ft, and argon about $2.00 to $2.50 per 100 cu ft.

Most argon is sold in high purities, with relatively little going into electronics-grade purities. Its major uses—specialty steels (mainly stainless) and other metals, welding, electronics, and light bulbs and tubes—all are growing modestly. Production of this gas likely will top 13 billion cu ft this year.

With prospects for improving demand during this decade, users of the major industrial gases may encounter supply problems. If past performance is an indicator, however, producers will meet the growing demand, assuming that selling prices rise enough to keep capacity expanding. □

Oxygen, nitrogen production to reach record highs



Note: Production from all sources except manufacture of ammonia and derivatives. **Sources:** Department of Commerce, C&EN estimates

Special government funds support basic research in key fields

The Japanese government is making a major effort to encourage basic research in a number of key areas. Several ministries sponsor these targeted programs in basic research. As in the U.S., most government-supported basic research is performed at universities, although company research labs and national laboratories play a key role in some of the targeted research programs.

The major source of special project grants for universities is the Ministry of Education, Science & Culture. Proposals for these grants are not so detailed as those required by the National Science Foundation or National Institutes of Health in the U.S., and the selection process for proposals is also far less rigid than the thorough peer review system followed in the U.S. The Japanese language is a major handicap in writing proposals because of the slow speed of Japanese-language computers.

These grants come in four general types. General-purpose grants cover equipment, reagents, and glassware. These range in scope from grants of $75,000 to $365,000 over four or more years to purchase major pieces of equipment, such as NMR instruments or mass spectrometers to single-year awards in the range of $20,000 for reagents and glassware.

A second category is targeted project grants. These $1 million to $3 million grants over the course of three years are awarded to giant project teams that involve 30 or more research groups, called kozas. In any given year, five or six of these grants will be in chemical fields, for topics such as dynamic natural products, gangliosides, or hypervalency. The kozas that make up the project team hold two open meetings to report their progress each year and usually have an additional meeting to discuss ongoing work. Each member koza receives a grant from the project of about $30,000.

I would prefer to see these grants distributed independently to the same number of research groups following a fair selection process. Under the present arrangement, the head of the research team exerts too much influence on the member kozas. This pyramidal hierarchy mirrors the prevailing pattern throughout Japanese culture and has to be curbed. A smaller team of research groups could more effectively advance a research area.

Another problem with these large project team grants is the amount of time required to attend the group gatherings. Since results coming from the grant-supported work will appear in scientific journals, preparation of progress reports and final reports for these projects is redundant.

The Ministry of Education, Science & Culture also awards special promotion grants to outstanding research groups. These awards of about $1.5 million over a period of three years are particularly attractive because they are the largest grants available to individual kozas. Recipients are active researchers at the forefront of Japanese science and are selected on the basis of their achievements and reputation. Chemistry usually receives three to seven of these grants each year.

The fourth category of grants is seed grants, awarded for one year to researchers who are less than 37 years old. These grants are usually for less than $9000.

In order to encourage more students to enter Ph.D. programs, the government—through the Ministry of Education, Science & Culture—has initiated a Special Graduate Student Program, which provides students with stipends of $880 per month. Ordinarily graduate students receive loans from the government of $580 per month, which they must repay unless they become teachers. Under the Special Graduate Student Program, students can also apply for research grants of $7300 per year. Some

Frontier Research Project, begun in 1986 and funded by the Science & Technology Agency. All of these new ventures stress interdisciplinary collaboration and have an international flavor.

Many government agencies are striving to create projects with novel concepts. But when too much emphasis is placed on grand projects, more subtle basic research that does not appeal to mass media tends to be forgotten. Without quiet, fundamental research, basic findings leading to the more media-appealing technological or medical discoveries will inevitably be weakened.

In view of the importance of basic science to industry, the Ministry of International Trade & Industry, which has for many years actively promoted and subsidized technology development in industry, has started to consider subsidizing university laboratories. Industry also realizes that it has an important role in rapidly transforming the old image of Japanese science. It is increasingly subsidizing academic research, as well as performing first-class interdisciplinary research within its own research laboratories.

Lagging behind these organizational and financial transformations is the human response at universities. Japanese universities have considerable autonomy, and could, at least in theory, develop and implement their own unique programs. The senior professor's rank is comfortable, however, and, in certain cases, this comfort may be dampening the drive to introduce drastic changes.

Probably a more serious problem for universities, however, is that the various parts of national universities are too autonomous. An American university is more autocratic: Presidents, deans, or department chairmen have far more authority than their Japanese counterparts and can make important decisions with much less consultation with other faculty. In Japan, universities have an excessive number of committee or general meetings at practically every level. Japanese professors spend many more hours in committee and faculty meetings, and decisions are overly based on consensus. Monthly faculty meetings are attended by all professors, which, in the case of the faculty of science, includes those in chemistry, biology, physics, mathematics, and several other fields. Professors are entrapped by these meetings, which are a steady drain on their time. The Japanese people are more "polite" and less outspoken than their American counterparts, so their

Fiscal 1989 funding	$ Millions
Ministry of Education, Science & Culture	**$397.9**
Scientific research	384.0
Special graduate and postdoctoral program	13.9
Science & Technology Agency	**75.1**
Basic research	10.2
Basic interdisciplinary research	5.8
Postdoctoral program	2.2
Creative Science & Technology Program	33.6
Frontier Research Program	12.4
Human Frontier Science Program	10.9
Ministry of Health	**40.0**
Ministry of International Trade & Industry	**56.2**
Basic industrial technology for the future	49.6
Human Frontier Science Program	6.6
Ministry of Agriculture & Fishery	**5.8**
Ministry of Postal Services	**0.7**
TOTAL	**$575.7**

Note: Figures are for the year ending March 31, and are converted from yen using the rate $1.00 = 137 yen. **Source:** Science & Technology Agency of Japan

postdoctoral fellowships are also available, with priority for these fellowships given to candidates who transfer to groups other than the one in which they received their graduate training.

Japan has been criticized for the large imbalance between the number of Japanese who study in the U.S. or Europe and the number of scientists from those countries who come to Japan. To address this issue, both the Ministry of Education, Science & Culture and the Science & Technology Agency have initiated postdoctoral and cooperative research programs that support invited foreign scientists in Japanese government and university laboratories.

The Science & Technology Agency also provides grants to support basic research programs in a number of fields. Its grants in creative science and technology are for five years and support teams of government, industry, and university laboratories working in designated areas. Currently the areas being supported are materials science, life science, communication science, and marine science. Although the grants are appreciated, they require far too much paperwork, including frequent progress reports.

Another innovative approach of this agency is the Frontier Research Program begun in 1986 by Ryogo Kubo, an emeritus professor at the University of Tokyo. Its offices and impressively equipped laboratories are in buildings adjoining the huge Institute of Physical & Chemical Research (known as Riken) north of Tokyo. Projects run on five- to seven-year contracts and are headed by top-quality team and group leaders. The program operates by a flexible and cosmopolitan system quite different from traditional research teams. Group leaders and staff are recruited internationally, and the program's scientific advisory group also includes several foreign scientists. The second set of eight-year projects under this program started in the fall of 1991 under the direction of Masao Ito. Their topics are the functioning of mental processes, frontier materials, saccharide information storage, and plant homeostasis.

Binational and multinational cooperative research projects are supported by grants awarded by the Science & Technology Agency and the Ministry of International Trade & Industry. Under these grants, each member research group receives about $25,000.

Koji Nakanishi

faculty meetings go on and on, chewing up precious time.

Despite these drawbacks, the concerted efforts going on in Japan mean that the transition will continue and the conduct of basic research in academe will inevitably change for the better. The overhaul of the research system will probably be quite slow at existing universities, but many new education and research institutes have already started, and here change will be much more rapid.

As mentioned earlier, Japan is in the process of ecdysis to a more modern image and structure. There is no question that the overall level of chemical education and research is presently higher in the U.S. than in Japan. However, in terms of plans for future development, the picture for Japan seems brighter. Numerous ambitious plans are being realized in Japan, thanks to its prospering economy. This contrasts favorably with the present overall atmosphere in many other countries, where the major concern is how to stop erosion of science funding. However transient this economic trend may turn out to be, there is an acute realization in Japan that drastic changes in the country's conservative philosophy and social structure have to occur in order for the country to become a leading and respected member of the modern world community.

I have been a bitter critic of the Japanese system, but I'm encouraged by these changes. In many cases, the U.S. and Japan represent two policy extremes, and each could benefit by adopting some of the other's programs.

I am grateful to my five colleagues who contributed their informative essays on short notice. I thank, as well, Kenji Mori of the University of Tokyo for bringing the Japanese Science Council questionnaire results to my attention; as a JSC member, he was heavily involved in the project. I am also grateful to other colleagues who have provided me with updated information. □

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